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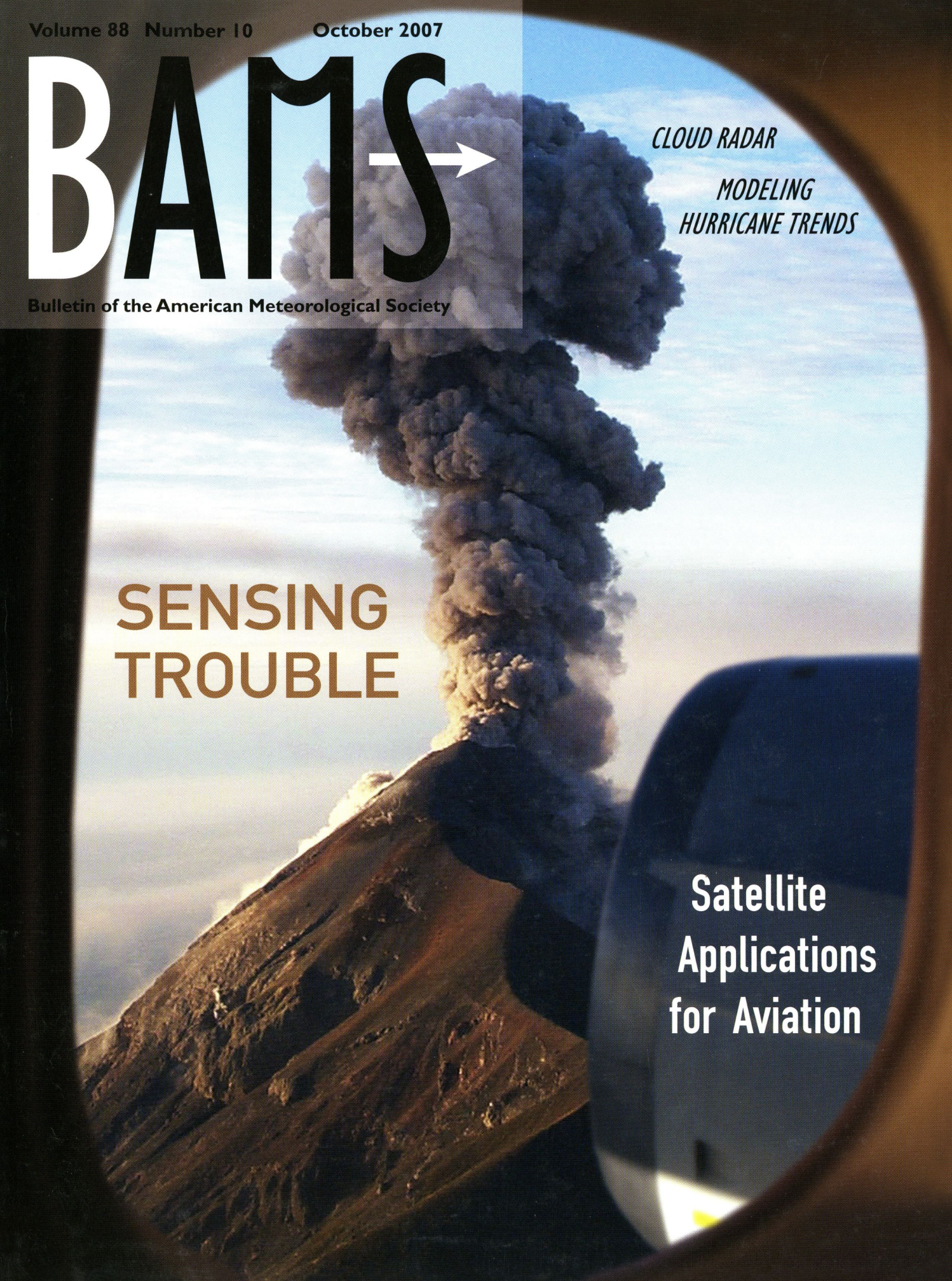

CLOUD RADAR

MODELING HURRICANE TRENDS

SENSING TROUBLE

Satellite Applications for Aviation

A 1954 COLOR PAINTING OF WEATHER SYSTEMS AS VIEWED FROM A FUTURE SATELLITE

BY JAMES FLEMING

The Harry Wexler Papers in the Library of Congress contain a copy of *Aviation Week* for 3 February 1958 with a black-and-white image on the cover depicting how the Earth and its weather systems might appear as transmitted by television from a satellite vehicle. I had seen the magazine in the library of the National Air and Space Museum and had also found black-and-white glossy prints of the image many times in various collections—in one case, with the intriguing caption, "taken from an original color image." I had looked for the color image, to no avail, in the National Archives, NOAA Central Library, and elsewhere. Thinking I would simply return the magazine to its archival box, a color photograph fell out of the front of the magazine. I whooped for joy. Librarians and patrons looked askance. Here it was (Fig. 1), a photograph of the color painting Wexler had commissioned in 1954.

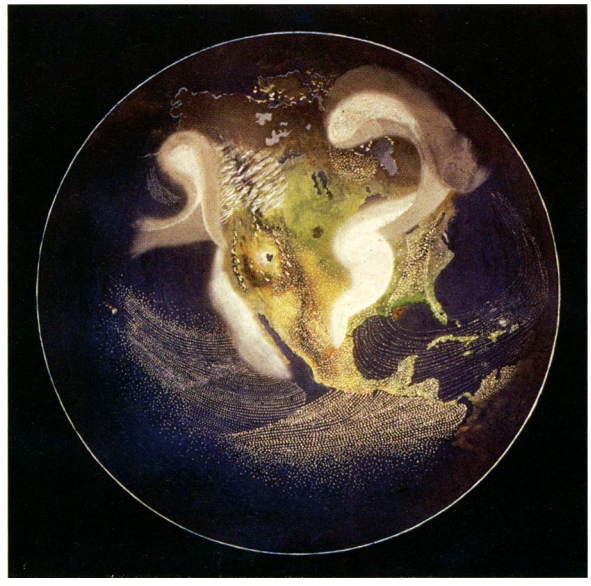

FIG. 1. Weather systems over North America as they might appear from a satellite 4,000 miles above Amarillo, Texas, on June 21. The painting was commissioned by Dr. Harry Wexler, director of meteorological research, U.S. Weather Bureau. Surface features are drawn taking into account Earth's normal colors, reflectivity of sunlight, and scattering and depleting effects of light passing through the atmosphere, with calculated brightness of various cloud types. Weather features include a family of three cyclonic storms extending southwest from Hudson Bay to Texas; a similar system over the Bay of Alaska; small hurricane developing near Puerto Rico; meeting zone of northeast and southeast trade winds, extending west of the Isthmus of Panama to mid-Pacific; line squall in the eastern U.S.; scattered cumulus clouds over heated land areas; lenticular clouds usually found where the jet stream crosses mountains, as over the northern Canadian Rockies; and low stratus and fog off the California coast, over the Great Lakes, and in the Newfoundland area. (SOURCE: Harry Wexler Papers, Library of Congress)

Wexler used the black-and-white version of the image in his lectures in 1954 at the Hayden Planetarium symposium on space travel, and in 1956 at the honors-night dinner talk before the American Astronautical Society. Encouraged by the novelist and futurist Arthur C. Clarke, Wexler published versions of his remarks in the *Journal of the British Interplanetary Society* (vol. 13, pp. 269–276) and in the *Journal of Astronautics* (vol. 4, pp. 1–6). In his lectures he made a strong claim for the utility of the meteorological satellite, not only as a "storm patrol," but also as a potentially revolutionary new tool with global capabilities (Wexler 1956; Logsdon 1998).

> Since the satellite will be the first vehicle contrived by man that will be entirely out of the influence of weather, it may at first glance appear rather startling that this same vehicle will introduce a revolutionary chapter in meteorological science—not only by improving global weather observing and forecast-

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ing, but by providing a better understanding of the atmosphere and its ways. There are many things that meteorologists do not know about the atmosphere, but one thing they are sure of is this—that the atmosphere is indivisible—that meteorological events occurring far away will ultimately affect local weather. This global aspect of meteorology lends itself admirably to an observation platform of truly global capability—the Earth satellite.

After mentioning earlier accomplishments of a V-2 rocket flight in 1947 that photographed clouds from an altitude of 100 miles and an Arobee rocket launch in 1954 that identified a previously unknown tropical storm in the Gulf of Mexico, Wexler continued:

> What would be seen from the vehicle at some 4,000 miles above Amarillo, Texas, if it were exactly noon this time on June 21? An attempt has been made to portray the scene under the assumption that the sun is directly overhead. The surface features of the Earth were first drawn by taking into account its normal color and reflectivity of sunlight, and the scattering and depleting effects on the passage of light through the Earth's atmosphere. Albedo values were assigned to various cloud types and their brightness computed. A colored drawing was made but is not shown here; however, a black and white photo of it is given . . . which contains the following major features:
>
> a) A cyclone family of three storms in various stages of development extending from Hudson Bay southwestward to Texas.
> b) The northeastern part of another such cyclone family whose oldest member is in the Gulf of Alaska, the remaining members to the southwest being invisible.
> c) A small hurricane embedded in "streets" of trade cumuli north of Puerto Rico.
> d) The Intertropic Convergence Zone (or Equatorial Front)—a zone of interaction between the northeast trades of the Northern Hemisphere and the southeast trades of the Southern Hemisphere—extending west of the Isthmus of Panama to the mid-Pacific.
> e) A "line-squall"—favorite breeding ground of severe wind storms and tornadoes—in the eastern U.S. moving ahead of the cold front and surrounded on both sides by the cauliflower-like cumulus congestus.
> f) Scattered cumulus clouds of varying thickness over the heated land areas—especially in the mountains and other areas where dynamic effects encourage the lifting of air in vertical columns.
> g) Altocumulus lenticularis or lens-shaped clouds formed by lifting of wide layers of moist air over mountains, as over the northern Canadian Rockies.
> h) Low stratus and fog found off the southern and lower California coasts, over the Great Lakes, and the Newfoundland area—formed by passage of warm, moist air over cold surfaces.
>
> The cumulus cloud systems over the oceans will tend to fall in fairly regular patterns or "streets." . . . The regularity and detail of the ocean cloud systems in the present sketch are exaggerated but their breakdown into a more irregular pattern over land is in the right direction. The centers of the anticylonic or "high pressure" areas are marked by little or no cloud.
>
> This then is the hypothetical picture visible from the 4,000-mile-high vehicle over Amarillo, Texas. Some of these clouds, such as the trade cumuli, could undoubtedly be observed on almost any day and others, such as the hurricane, seen only rarely. The cyclone families would be observed daily, but their location, the number of individual storms, size and intensity would vary geographically. A meteorologist, given a clear picture of the cloud distribution, as here portrayed, could without difficulty sketch in a very useful weather chart showing location of the various stormy and fair weather areas; in fact, he would have a much better idea of the large-scale

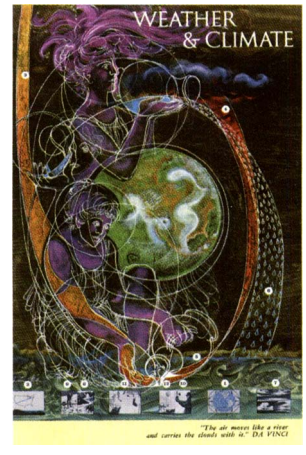

Fig. 2. Wexler's color painting was featured at the center of the weather and climate poster issued during the International Geophysical Year of 1957–58. [Source: U.S. National Academies, IGY "Planet Earth" posters and booklet (available from the National Academies at www7.nationalacademies.org/archives/IGYPlanetEarthPosters.html)]

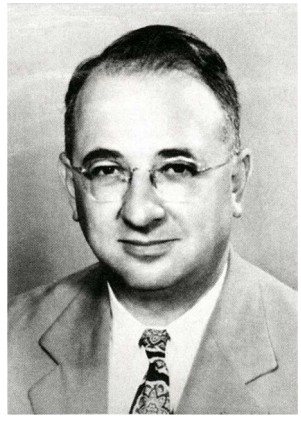

FIG. 3. Harry Wexler (1911–1962) was born in Fall River, Massachusetts, and earned a Ph.D. in meteorology from MIT under C. G. Rossby. He spent most of his career with the U.S. Weather Bureau and served as an instructor of military weather cadets during World War II. As head of research for the Weather Bureau, Wexler participated in the development of a number of new technologies, including airborne observations, sounding rockets, radar, the use of electronic computers for numerical weather prediction and general circulation studies, and satellite meteorology. He also served as chief scientist for the U.S. expedition to the Antarctic for the International Geophysical Year, 1957–58, and established a number of atmospheric baseline measurements of trace gases, including carbon dioxide and ozone. From the early 1950s, Wexler promoted the use of satellites in meteorology. Wexler, who played a central role in the development of *Explorer* and *TIROS*, foresaw that information gathered from satellites would be of great value for warning of severe weather, measuring the Earth's heat budget, and monitoring environmental changes, both immediate and long-term. Always interested in global studies of weather and climate, Wexler was an enthusiastic promoter of the World Weather Watch, which became a reality in 1963, shortly after his death. (SOURCE: Harry Wexler Papers, Library of Congress)

weather distribution than his Earth-bound colleague, who is forced to rely on scattered observations taken at or near the Earth's surface.

After a technical discussion of satellite orbits, ground tracks, and image orientation, Wexler pointed out, "The hurricane, with its cloud bands similar to the arms of a spiral nebula, and its open 'eye' at the center, might be [an easy] storm to detect and follow accurately."

Harry Wexler was cut down in the prime of his career by a heart attack in 1962. Five years after his death, a color spin-scan camera flew on the geosynchronous satellite *ATS 3*, and since then color imagery of the Earth's weather systems has become both widely available and extremely useful. In 2007–08, the space science and geophysical communities are celebrating several significant 50th anniversaries: the beginning of the International Geophysical Year, the launches of *Sputnik 1* and *2* and *Explorer 1* and *3*, and the founding of NASA. Upcoming scholarly meetings and publications include an international conference on "Making Science Global", a publication on the first 50 years of *Earth Observations from Space*, and a symposium on Earth observations at the American Association for the Advancement of Science meeting in Boston, Massachusetts. As we celebrate, it is right to remember the role played by Harry Wexler in exposing the American public to the concept of an artificial satellite as something more than science fiction.

FOR FURTHER READING

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